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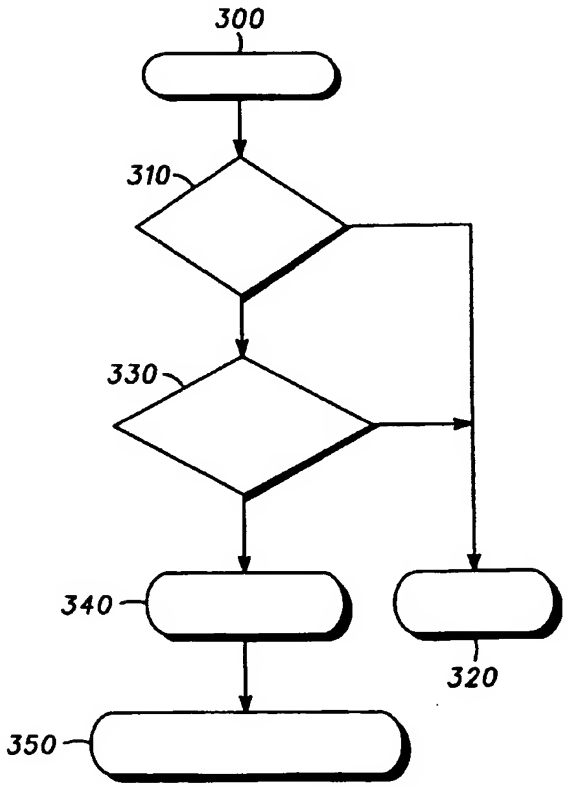
(54) Title: METHOD FOR ENABLING A MOBILE STATION TO RECEIVE A CIRCUIT-SWITCHED PAGE



(57) Abstract: A mechanism for notifying a mobile station operating in a packet-switched data interchange activity of receipt of a circuit-switched paging message in a GSM communication system. A radio link control/medium access control block is sent to a mobile station by being inserted in a packet data channel, corresponding to the packet-switched data interchange activity, in response to the mobile station being capable of operating in a dual transfer mode (310) and being currently engaged in packet-switched data interchange activity (330). The mobile station aborts the packet-switched data interchange activity, and monitors a combined control channel setting up for circuit-switched voice interchange activity containing simultaneous voice and data transmission, resulting in a simultaneous voice and data transmission in dual transfer mode (350).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD FOR ENABLING A MOBILE STATION TO RECEIVE A CIRCUIT-SWITCHED PAGE

FIELD OF THE INVENTION

The present invention relates generally to signaling in a GSM communication system, and in particular, the present invention relates to a method for receipt of paging messages from a circuit-switched data domain while a mobile station is involved in the interchange of packet-switched data.

BACKGROUND OF THE INVENTION

Global System for Mobile Communications (GSM) General Packet Radio Service (GPRS) is intended to allow a service subscriber the ability to send and receive data in an end-to-end packet transfer mode without utilizing network resources in the circuit-switched mode. GPRS permits efficient use of radio and network resources when data transmission characteristics are i) packet based, ii) intermittent and non-periodic, iii) possibly frequent, with small transfers of data, e.g. less than 500 octets, or iv) possibly infrequent, with large transfers of data, e.g. more than several hundred kilobytes. User applications may include Internet browsers, electronic mail and so on.

The European Telecommunications Standards Institute (ETSI) GSM specifications define what is referred to as a "mobile station class" for GPRS mobile stations. The mobile station class specifies some of the behavior to which a mobile station must conform regarding its operation in packet mode, circuit-switched mode, or both packet and circuit-switched mode. For example, one such mobile station class is a Class A mobile station which supports simultaneous attachment, monitoring, activation, invocation and traffic flow on both circuit-switched voice and packet-switched data services. On the other hand, a Class B mobile station has been defined to support only simultaneous attachment, monitoring and activation on both circuit-switched voice and packet-switched data services, with invocation and traffic flow

possible on either service on a mutually exclusive basis. Finally, a Class C mobile station is defined to support only non-simultaneous attach, i.e. mutually exclusive attach, on either circuit-switched voice or packet-switched data services.

Mobile station classes may also be assigned, or changed, in some cases by the user, subject to limitations such as manufacturer's options and equipment limitations. For example, a user application may have the ability to issue a command to change the mobile station class of the subscriber equipment currently in use. The mobile station classes are therefore to be treated as "effective" classes, as users may exercise some control over mobile station class identity.

Efforts are presently underway to further develop ETSI GPRS specifications to specify required channelisation and signaling techniques that allow a mobile station, having a single receiver/transmitter, to handle a simultaneous GSM voice and packet session. This effort has led to the creation of a dual transfer mode (DTM), in which both GSM voice and GPRS, or EDGE, data can be interchanged on the same radio frequency (RF). When the mobile station is operated in dual transfer mode, the operational context of the mobile station contains an active circuit-switched voice connection in dedicated mode, and an active packet-switched temporary block flow (TBF) in GPRS/EDGE packet transfer mode.

Current GPRS networks include a process for coordinating transmission of paging for both circuit-switched data and packet-switched data services in which the GPRS network sends paging messages for circuit-switched service on the same channel as used for packet-switched services, i.e., on a GPRS paging channel or on a packet associated control channel. As a result, in order to receive paging services, the mobile station needs to monitor the packet associated control channel (PACCH) while the mobile station is currently engaged in packet-switched transfer, or the GPRS paging channel when the mobile station is not currently engaged in packet switched or circuit-switched data transfer.

As illustrated in FIG. 1, a mobile station 100, such as a wireless telephone device, communicates with a circuit-switched network 102 and a packet data network 104 by transmitting signals to and receiving signals from a base station 106. The base station 106 is coupled to a base station controller 108, which in turn is coupled to a mobile switching center 110 via an interface 112 commonly referred to as an "A

interface", and the mobile switching center 110 in turn interfaces with the circuit-switched network 102. As a result, it is possible for circuit-switched data to be transmitted between the mobile station 100 and the circuit-switched network 102 along a signal path that includes the base station 106, base station controller 108, and the mobile switching center 110.

Similarly, the base station controller 108 is coupled to a Serving GPRS Support Node (SGSN) 114, which keeps track of the location of the mobile station 100 and performs security functions and access control, and interfaces with the packet data network 104. As a result, it is possible for packet-switched data to be transmitted between the mobile station 100 and the packet data network 104 along a signal path that includes the base station 106, base station controller 108, and the SGSN 114.

A prior art GPRS network enables a mobile station operating in a packet transfer mode to receive a circuit-switched paging message by using an optional interface 116, commonly referred to as a "Gs interface", connecting the mobile switching center 110 and the SGSN 114. The Gs interface 116 enables the mobile station 100 to receive a circuit-switched paging message while engaged in a packet-switched data transfer, by transmitting the circuit-switched paging information from the mobile switching center 110 directly to the SGSN 114, along the Gs interface 116, rather than transmitting the paging message from the mobile switching center 110 through the base station controller 108 to the mobile station via a circuit-switched paging channel on the combined control channel (CCCH).

However, one of the problems associated with providing a Class A capable mobile station operating in an environment which does not support the optional Gs interface 116, is that, while engaged in a packet-switched data transfer whereby packet data is being interchanged between the mobile station 100 and the packet data network 104, the mobile station 100 is unable to schedule receipt of a circuit-switched paging block without preempting the reception of data from a packet data channel (PDCH), which would result in a loss of packet data throughput, since re-transmissions would be required to make up for missed data blocks. In addition, differences in the organization of multiframe structures of the packet data channel, on which pack-switched data is transmitted, and a combined control channel (CCCH), on which paging and access grant channels (PAGCH) are transmitted, makes scheduling

of reception of a circuit-switched paging block by the mobile station while in a GPRS or EDGE packet transfer problematic.

For example, as illustrated in FIG. 2, the packet data control channel is organized as a multiframe 100 having fifty-two frames 102 and twelve data blocks B0-B11, in which each data block B0-B11 is distributed over four time division multiple access (TDMA) frames. An "idle" or "search" frame 106, located after every three data blocks, enables the mobile station to perform adjacent cell signal measurements, synchronization and verification of synchronization status on adjacent cells, interference measurements, and so forth. Each data block B0-B11 is made up of four frames, each of which has a frame period f equal to 4.61538 milliseconds, and a block period b that is equal to 18.4616 milliseconds, while each idle frame 106 has an idle frame period I that is equal to the frame period f, or 4.61538 milliseconds. The total period of the multiframe 100 structure of the packet data channel is equal to 240 milliseconds.

A combined control channel, on the other hand, is organized as a multiframe 108 having fifty-one frames 110, with the frame period f of each frame being equal to 4.61538 milliseconds. The multiframe includes nine groups of four frames 1-9 that include paging and access grant control channels, a four contiguous frame block 114 that is a broadcast channel, and two idle frames 116 positioned between each group of eight frames. The total period of the multiframe 108 structure of the paging and access grant control channel is equal to 235.385 milliseconds.

As can be seen in FIG. 2, the structure of the multiframe 100 for the packet data channel differs from the structure of the multiframe 108 for the combined control channel, and as a result, the two channels are non-harmonically related so that the packet data control channel and the combined control channel slip in and out of phase relative to each other as a function of time. Since the only opportunity for the mobile station to read a circuit-switched paging block would be during periods corresponding to the idle frames 106 of the packet data control channel, it is difficult for the mobile station to schedule reception of circuit-switched paging blocks, while the mobile station is engaged in a GPRS or EDGE packet transfer. In addition, since the total periods of the multiframes 100 and 108 are unequal, a paging group to which an idle frame refers at one point in time differs as time progresses, limiting the number of

appropriate paging blocks visible to the mobile station in an idle frame during a packet transfer.

Accordingly, what is needed is a method for receipt and handling of a paging message originating from a circuit-switched domain while a mobile station is operating in a packet transfer mode.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description, taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and wherein:

FIG. 1 is a schematic diagram of a communication network in a GPRS system.

FIG. 2 is a schematic diagram of multiframe structures for a packet data channel and a combined control channel.

FIG. 3 is a schematic diagram of a communication network, according to the present invention.

FIG. 4 is a signal flow diagram of a signaling path in a communication network according to the present invention.

FIG. 5 is a flowchart of a mechanism for notifying a mobile station of a circuit-switched paging message, according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is a method for a notifying a Class A GPRS dual transfer mode mobile station, operating in a packet transfer mode, of a circuit-switched paging message. Once notified of the circuit-switched paging message, the mobile station aborts a temporary block flow (TBF) on which the mobile station is currently interchanging packet-switched data, and returns to a combined control channel (CCCH) having random access to set up the circuit-switched voice connection corresponding to the circuit-switched paging message. The combined control channel is a signaling channel that sets up a simultaneous voice channel and

data channel according to dual transfer mode requirements. As a result, the mobile station is able to continue with the previously aborted packet data transfer and acquire a circuit-switched voice session.

As illustrated in FIG. 3, a communication network 200 according to the present invention includes a mobile switching center 202, and a plurality of cell sites 204. Each cell site 204 includes a base station 206 coupled to a base station controller 208. A protocol control unit 210 is coupled to or contained within each base station controller 208, and each protocol unit 210 interfaces with a Serving GPRS Support Node (SGSN) 212 which in turn interfaces with a packet data network 214. The base station controller 208 is coupled to the mobile switching center 102 along an A interface 215, and the mobile switching center 202 in turn interfaces with a circuit-switched network 216. The SGSN 212 can also be connected to other SGSNs belonging to other service providers, which in turn can also be connected other SGSNs, and so forth.

A mobile station 218, such as wireless telephone device, is adapted to communicate with base stations associated with each base station controller 208 to maintain communications with another mobile station, the circuit-switched network 216, or the packet data network 214. The mobile station 218 includes a transceiver 220 to receive signals from, and to transmit signals to the base station controller 208, and a processor 222 to process the signals sent to and received from the base station controller 208. The SGSN 212 keeps track of the location of the mobile station 218, and performs security functions and access control. It is understood that although only one mobile station 218 is shown in FIG. 3, more than one mobile station is located within the communication network 200 at one time.

FIG. 4 is a signal flow diagram illustrating a signaling path in a communication network according to the present invention. As illustrated in FIGS. 3 and 4, when the mobile station 218 is initially engaged in packet data transfer, an existing packet data transfer, line 224 of FIG. 4, takes place along a temporary block flow (TBF) so that the mobile station 218 is engaged in a packet data interchange via the SGSN 212 in packet-transfer mode. When circuit-switched information addressed to the same mobile station 218 is received by the mobile switching center 202 from the circuit-switched network 216, the mobile switching center 202 sends a circuit-

switched paging message along the A interface 215 to the base station controller 208, line 226, to inform the base station controller 208 of the circuit-switch information, including the intended mobile station 218. Based on the class mark of the intended mobile station 218, the base station controller 208 determines whether the mobile station 218 supports a dual transfer mode. In addition, the base station controller 208 also determines whether the mobile station 218 is currently in a temporary block flow.

According to the present invention, if the base station controller 208 determines that either the mobile station 218 does not support a dual transfer mode, or that the mobile station 218 is not currently in a temporary block flow, the circuit-switched message is sent to the mobile station 218 along the existing paging channel.

However, according to the present invention, if the base station controller 208 determines both that the mobile station 218 supports a dual transfer mode, and that the mobile station 218 is currently in a temporary block flow, the base station controller 208 sends a message to the protocol control unit 210, line 228, informing the protocol control unit 210 that a circuit-switched page is pending for the identified mobile station 218, and instructing the protocol control unit 210 to send a ciruit-switched paging message in a radio link control (RLC) control block to a radio resource (RR) layer of the mobile station 218. The protocol control unit 210 then sends a radio link control/medium access control (RLC/MAC) control block to the base station controller 208, and the base station controller 208 sends the RLC/MAC control block to the mobile station 218 by inserting the RLC/MAC control block within a block of the 52 frame multiframe structure of the packet data channel, line 230. The inserted RLC/MAC control block indicates to the mobile station 218 that "the addressed mobile station is now being circuit-switched paged". According to the present invention, for example, the RLC/MAC control block notifying the mobile station 218 of the circuit-switched paging message can be located in either of blocks B0-B11 of the packet data channel multiframe 100 of FIG. 2.

Once the transceiver 222 of the mobile station 218 receives the RLC/MAC control block notifying the mobile station that it is being circuit-switched paged, the processor 220 of the mobile station 218 processes the RLC/MAC control block and determines that the mobile station 218 is being circuit-switched paged. As a result, the mobile station 218 aborts its current packet data transfer, and begins monitoring a

combined control channel with random access, i.e., the mobile station 218 is now in an idle mode, setting up for circuit-switched voice interchange activity using known signaling sequences, line 232 of FIG. 4. The combined control channel may also be used to exchange signaling information in order to set up a simultaneous voice channel and data channel according to dual mode transfer requirements. This enables the mobile station 218 to continue with the previously aborted packet data transfer and acquire a circuit-switched voice session. The user channel preferably includes one-half traffic channel and one-half packet data channel (TCH/H + PDCH/H), or may optionally include a full traffic channel plus one or more contiguous packet data channels (TCH/F + PDCH/F).

Upon completion of the signal flow described above corresponding to lines 226-232 of FIG. 4, data is now interchanged between the mobile switching center 202 and the mobile station 218 in the form of circuit-switched data, line 234, and between the SGSN 212 and the mobile station 218 in the form of packet-switched data, line 236, so that the mobile station 218 is now operating in a simultaneous voice and user packet data session.

FIG. 5 is a flow chart of a mechanism in a communication network for notifying a mobile station of a circuit-switched paging message, according to the present invention. As illustrated in FIG. 5, after a circuit-switched paging message originating from a circuit-switched domain is received by a base station controller from a mobile switching center, Step 300, the base station controller determines whether the mobile station is capable of operating in a dual transfer mode, Step 310, using the mobile station class mark. If the base station controller determines the mobile station is not capable of operating in dual transfer mode, the circuit-switched paging message is sent to the mobile station on the paging channel (PGCH), Step 320.

If the base station controller determines that the mobile station is capable of operating in a dual transfer mode in Step 310, the base station controller then determines whether the mobile station is currently engaged in packet-switched data interchange activity, Step 330. If the base station controller determines in Step 330 that the mobile station is not currently engaged in packet-switched data interchange activity, the circuit-switched paging message is sent to the mobile station on the paging channel (PGCH), Step 320. On the other hand, if the base station controller

determines in Step 330 that the mobile station is currently engaged in packet-switched data interchange activity, the base station controller informs the protocol control unit which mobile station is being paged, and the protocol control unit sends the RLC/MAC control block to the mobile station within a block of the packet data channel multiframe, Step 340.

Upon receiving the RLC/MAC control block, the mobile station realizes that it is being paged, aborts its current packet data transfer, and begins monitoring a combined control channel with random access to set up the circuit-switched voice connection, Step 350, which may include a user data channel with allocation for a voice channel and a data channel according to dual transfer mode requirements.

As a result of the signaling of the present invention, a simultaneous voice and data session is created enabling the mobile station to continue with the aborted packet data transfer and acquire the circuit-switched voice session. In this way, the present invention provides a mechanism for receipt and handling of a paging message that originates from a circuit-switched domain while a mobile station is engaged in a packet-switched domain data interchange.

While a particular embodiment of the present invention has been shown and described, modifications may be made. It is therefore intended in the appended claims to cover all such changes and modifications which fall within the true spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A method for notifying a dual transfer mode mobile station of a circuit-switched paging message, comprising the steps of:

determining capabilities of the mobile station;

sending a control block informing the mobile station of the circuit-switched paging message; and

providing a signaling path utilizing a combined control channel, by which the mobile station and base station interchange signaling information in order to set up simultaneous voice and packet-switched data interchange activity.

2. The method of claim 1, wherein the control block is inserted in a packet data channel corresponding to the packet-switched data interchange activity.

3. The method of claim 2, wherein the control block is a radio link control/medium access control block.

4. The method of claim 1, further comprising the steps of:

aborting the packet-switched data interchange activity;

monitoring the combined control channel setting up for circuit-switched voice interchange activity; and

creating the simultaneous voice and data transmission in dual transfer mode in response to the mobile station being capable of operating in a dual transfer mode and being currently engaged in packet-switched data interchange activity.

5. The method of claim 4, further comprising the steps of:

sending the circuit-switched paging message along a paging channel in response to the mobile station not being capable of operating in a dual transfer mode; and

sending the circuit-switched paging message along the paging channel in response to the mobile station not being currently engaged in packet-switched data interchange activity.

6. The method of claim 5, wherein the simultaneous voice and data transmission occurs along a channel that includes a one-half traffic channel and a one-half packet data channel.

7. The method of claim 5, wherein the simultaneous voice and data transmission occurs along a channel that includes a full traffic channel and one or more contiguous packet data channels.

8. A method of notifying a mobile station of a circuit-switched page, comprising the steps of:

determining whether the mobile station is capable of operating in a dual transfer mode;

determining whether the mobile station is currently engaged in packet-switched data interchange activity;

sending a control block informing the mobile station of the circuit-switched page in response to the mobile station being capable of operating in a dual transfer mode and being currently engaged in packet-switched data interchange activity;

aborting the packet-switched data interchange activity;

monitoring the combined control channel setting up for circuit-switched voice interchange activity; and

creating a simultaneous voice and data transmission in dual transfer mode.

9. The method of claim 8, wherein the control block is inserted in a packet data channel corresponding to the packet-switched data interchange activity.

10. The method of claim 8, wherein the control block is a radio link control/medium access control block.

11. The method of claim 8, further comprising the steps of:

sending the circuit-switched paging message along a paging channel in response to the mobile station not being capable of operating in a dual transfer mode; and

sending the circuit-switched paging message along the paging channel in response to the mobile station not being currently engaged in packet-switched data interchange activity.

12. The method of claim 11, wherein the simultaneous voice and data transmission occurs along a channel that includes a one-half traffic channel and a one-half packet data channel.

13. The method of claim 11, wherein the simultaneous voice and data transmission occurs along a channel that includes a full traffic channel and one or more contiguous packet data channels.

14. A mobile station sending and receiving signals from a base station controller of a communication system, the mobile station comprising:

a transceiver receiving a control block informing the mobile station of a circuit-switched paging message in response to the base station receiving a circuit-switched page addressed to the mobile station; and

a processor processing the control block and providing a signaling path, utilizing a combined control channel, by which the mobile station and base station exchange signaling inorder to set up a simultaneous circuit-switched voice and packet-switched data interchange activity.

15. The mobile station of claim 14, wherein, in response to receipt of the control block, the processor instructs the mobile station to abort the packet-switched data interchange and monitor the combined control channel settting up for circuit-switched voice interchange activity to create a simultaneous voice and data transmission in dual transfer mode in response to the mobile station being capable of operating in a dual

transfer mode and being currently engaged in packet-switched data interchange activity.

16. The mobile station of claim 15, wherein the control block is inserted in a packet data channel corresponding to the packet-switched data interchange activity.

17. The mobile station of claim 16, wherein the control block is a radio link control/medium access control block.

18. The mobile station of claim 17, wherein:

the circuit-switched paging message is sent along a paging channel in response to the mobile station not being capable of operating in a dual transfer mode, and

the circuit-switched paging message is sent along the paging channel in response to the mobile station not being currently engaged in packet-switched data interchange activity.

19. The mobile station of claim 18, wherein the simultaneous voice and data transmission occurs along a channel that includes a one-half traffic channel and a one-half packet data channel.

20. The method of claim 18, wherein the simultaneous voice and data transmission occurs along a channel that includes a full traffic channel and one or more contiguous packet data channels.

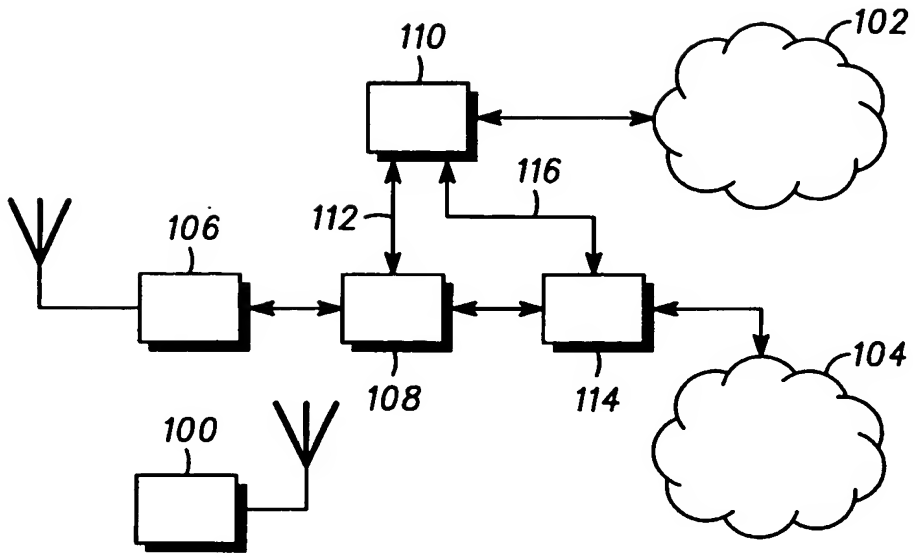
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FIG. 1

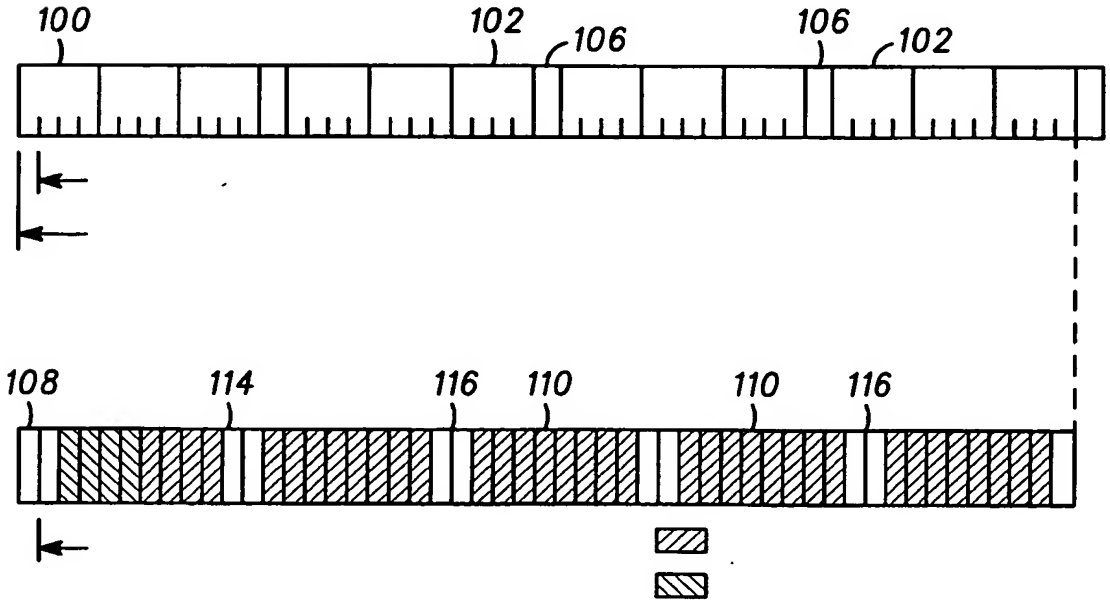
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FIG. 2

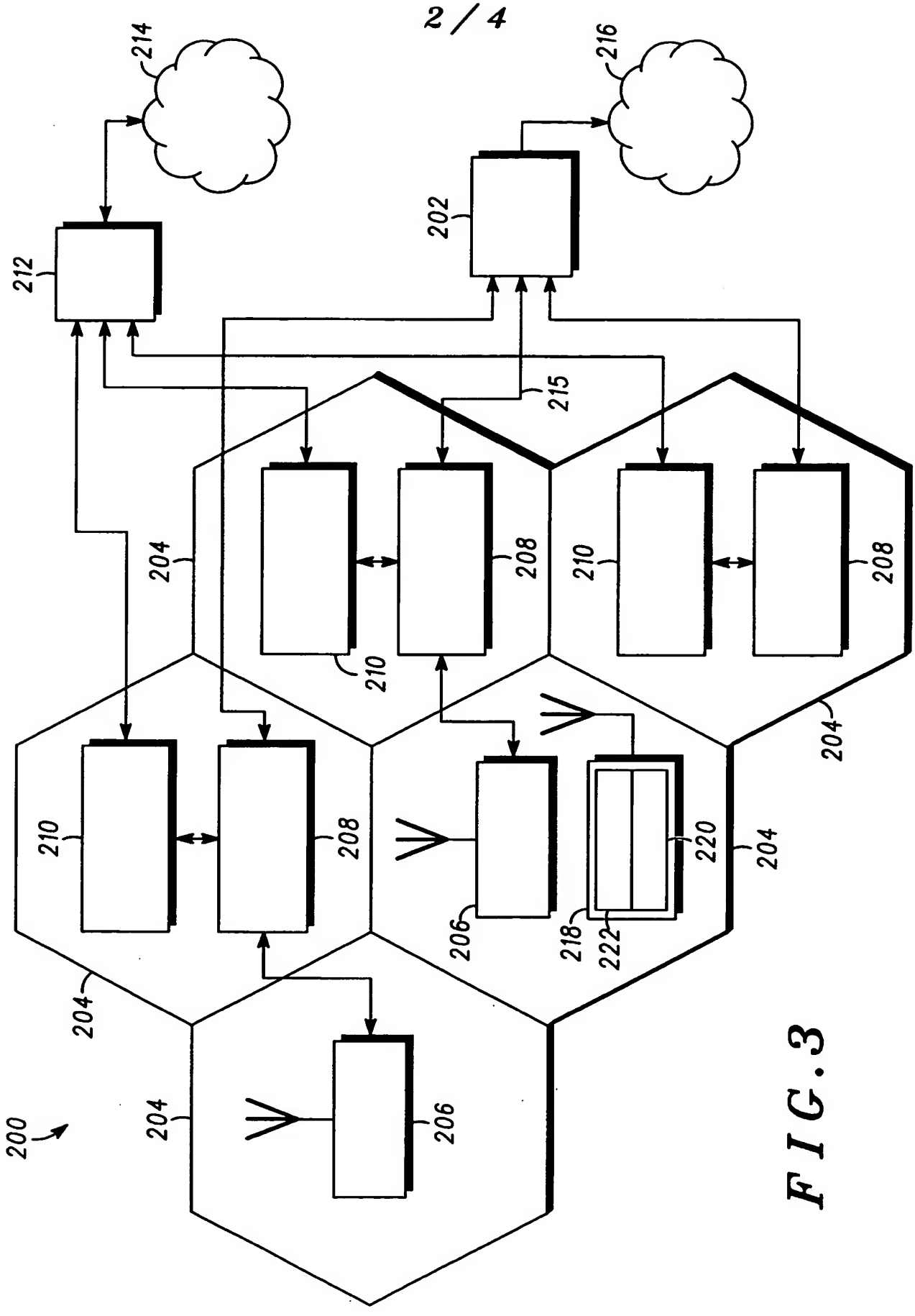


FIG. 3

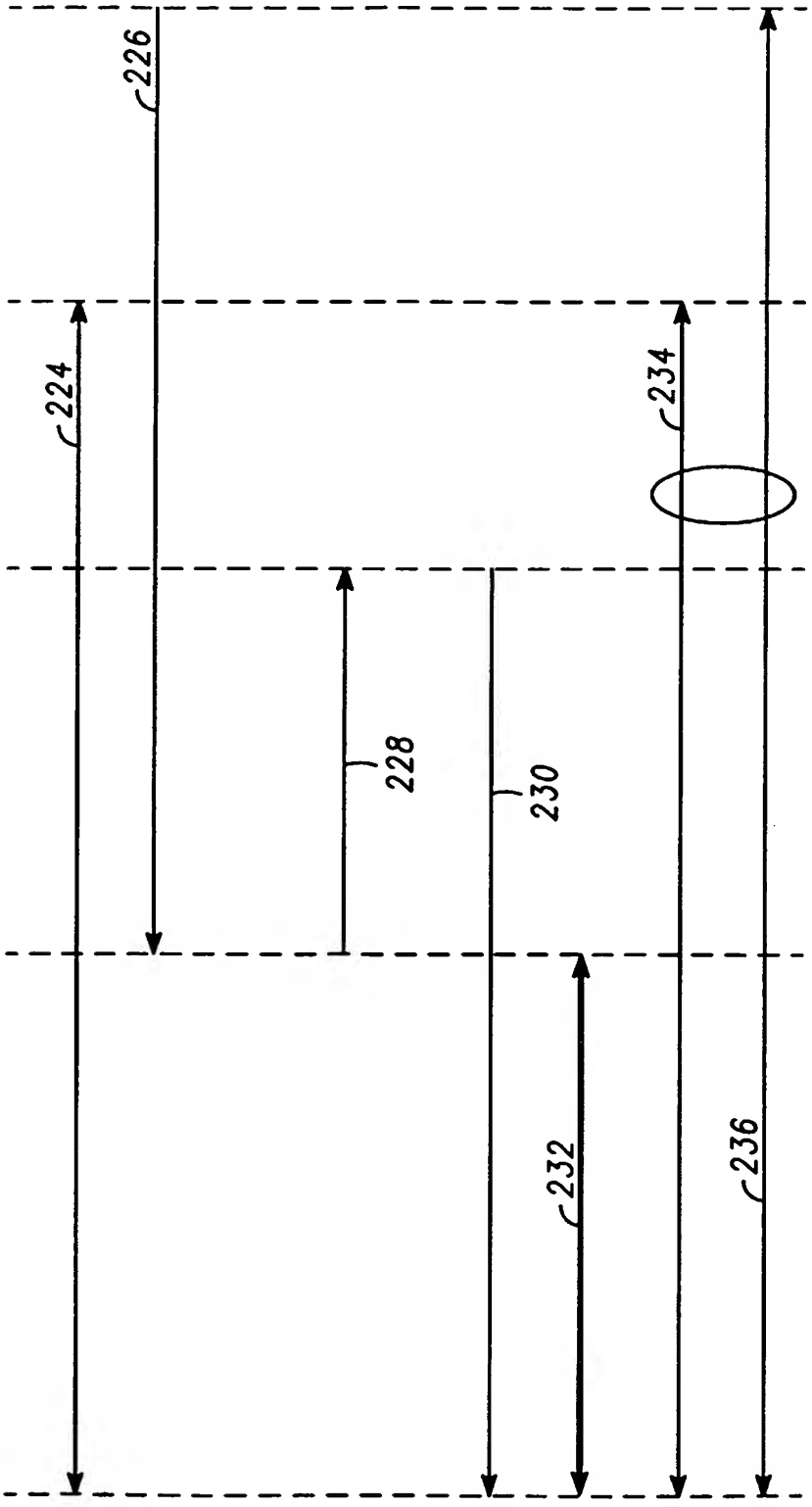
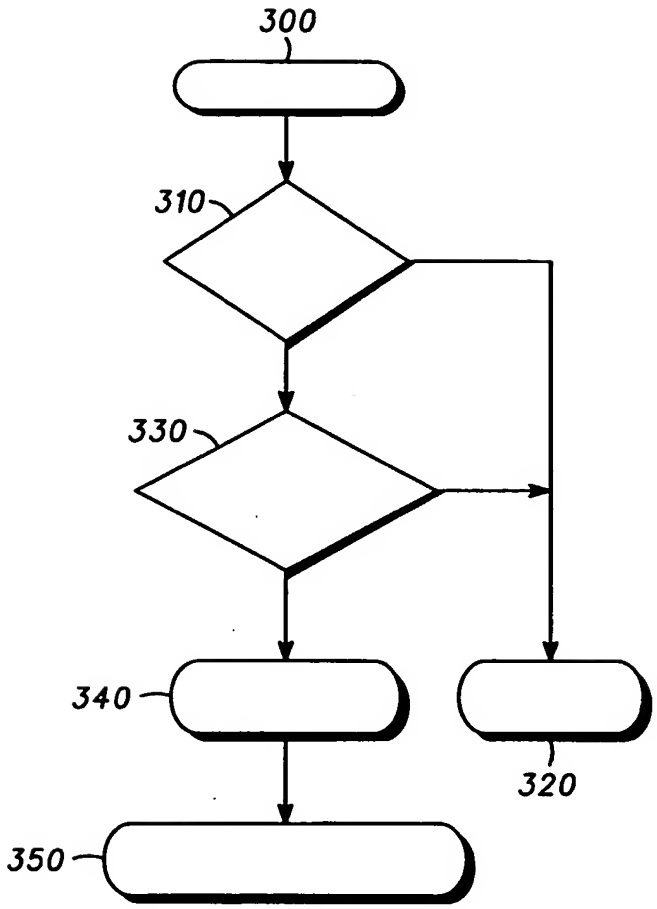


FIG. 4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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/10034

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : H04L 12/66; H04Q 7/00
US CL : 370/313, 352; 340/7.22, 7.28
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 370/310, 313, 352, 3358, 493, 496; 340/7.22, 7.28; 455/458

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	US 6,134,453 A (SAINTON et al.) 17 October 2000, column 10, lines 15-22; column21, lines 40-67.	1, 8 and 14
A,P	US 6,047,194 A (ANDERSSON) 04 April 2000, entire document.	1-20
A	US 5,754,554 A (NAKAHARA) 19 May 1998, entier document.	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2001 (29.05.2001)	17 JUL 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Saba Tsegaye Telephone No. (703) 308-4754

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/10034

Continuation of B. FIELDS SEARCHED Item 3: EAST
mobile, voice, data, packet, dual mode, simultaneous